# An economic evaluation of thrombolysis in a remote rural community

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## Abstract

**Objectives:** To assess the cost effectiveness of community thrombolysis relative to hospital thrombolysis by investigating the extra costs and benefits of a policy of community thrombolysis, then establishing the extra cost per life saved by community thrombolysis.
**Design:** Economic evaluation based on the results of the Grampian region early anistreplase trial.
**Setting:** 29 rural general practices and one secondary care provider in Grampian, Scotland.
**Subjects:** 311 patients recruited to the Grampian region early anistreplase trial.
**Interventions:** Intravenous anistreplase given either by general practitioners or secondary care clinicians.
**Main outcome measures:** Survival at 4 years and costs of administration of thrombolysis.
**Results:** Relative to hospital thrombolysis, community thrombolysis gives an additional probability of survival at 4 years of 11% (95% confidence interval 1% to 22%) at an additional cost of £425 per patient. This gives a marginal cost of life saved at 4 years of £3890 (£1990 to £42 820).
**Conclusions:** The cost per life saved by community thrombolysis is modest compared with, for example, the cost of changing the thrombolytic drug used in hospital from streptokinase to alteplase.

## Introduction

Large randomised controlled trials have shown that thrombolytic therapy significantly reduces mortality associated with acute myocardial infarction.[1] Differences in the effectiveness of alternative thrombolytic drugs are small, but the timing of thrombolysis has a large impact on mortality.[2] The British Heart Foundation recommends that thrombolysis should be given within 90 minutes of the call for medical assistance.[3] In areas lying more than 30 minutes' travelling time from main hospitals this target will be achieved only if general practitioners initiate thrombolytic therapy.

In the Grampian region early anistreplase trial (GREAT), early thrombolytic therapy given by general practitioners (community thrombolysis) reduced the mortality in comparison with hospital thrombolysis by 11% at one year and 15% at 2.5 years,[2 4] and the study population involved in the trial has now been followed up for four years. With appropriate training and support for general practitioners these results could be replicated in rural communities elsewhere in Britain.[5] In the Grampian trial, the thrombolytic agent used in the community and in hospital was anistreplase, which is given as an intravenous injection. The standard hospital thrombolytic is streptokinase, which is cheaper than anistreplase but more difficult to administer because it is given as an intravenous infusion over one hour. To give thrombolytics appropriately, general practitioners may have to undergo training and acquire an electrocardiograph and resuscitation equipment. The aim of this paper is to establish, from the perspective of the health care purchaser, the extra cost per life saved by thrombolysis in the community, using data from the Grampian region early anistreplase trial. It should be noted that even before the start of the trial the general practitioners involved in the trial routinely attended patients with suspected acute myocardial infarction and that patients in the trial were at least 30 minutes' travelling time from hospital.

## Evaluation methods

This study compared standard hospital administered thrombolytic therapy with community thrombolysis. Table 1 shows the costs and consequences of thrombolysis in the community and hospital settings, based primarily on the information from the Grampian region early anistreplase trial.[2 4]

The costs are made up of drug costs (anistreplase or streptokinase, and aspirin), labour costs (including general practitioner training and visits) and capital costs (electrocardiograph and defibrillator). The current purchase price of all equipment was obtained and converted into an equivalent annual cost using a 6% discount rate and assuming a lifespan of five years. The cost per patient was then calculated by dividing the equivalent annual cost by the number of general practitioner visits per year. For this study one general practitioner visit occurred for each case of acute myocardial infarction. The number of general practitioner visits per year was calculated from the number of general practitioner visits in the Grampian region early anistreplase trial divided by the length of the trial and the number of practitioners. The cost of anistreplase was based on its recommended price. Anistreplase has a shelf life of three years; if general practitioners keep one or two injections each there is unlikely to be much

**Table 1** Costs and consequences of community and hospital thrombolysis (costs are 1996 values, rounded to tens of pounds)

| Setting | Probability of survival at 4 years | Additional probability of survival due to community thrombolysis (95% CI ) | Cost of thrombolysis per patient (£) | Additional cost of community thrombolysis per patient (£) | Marginal cost of life saved at 4 years by community thrombolysis |
|---|---|---|---|---|---|
| Hospital | 0.65 | | 85 | | |
| Community: | | | | | |
| Low estimate* | 0.76 | 0.11 (0.01 to 0.215) | 510 | 425 | 3890 (1990 to 42 820) |
| High estimate† | 0.76 | 0.11 (0.01 to 0.215) | 970 | 880 | 8000 (4100 to 88 100) |

*Assumes no capital expenditure and that general practitioners already attend suspected cases of acute myocardial infarction.
†Assumes purchase of electrocardiograph and defibrillator, and that general practitioner did not previously attend suspected cases of acute myocardial infarction.

wastage. Therefore, drug costs were not adjusted to account for expiry before use of the drug.

The cost estimates for community thrombolysis depend on different assumptions regarding the additional length of general practitioner visits and capital expenditure. A lower estimate was based on the assumption that no capital expenditure was necessary and that general practitioners already attended patients with suspected acute myocardial infarction. An upper estimate was based on the assumption that an electrocardiograph and defibrillator would need to be purchased, and that the general practitioner did not previously attend patients with suspected acute myocardial infarction. The time cost of general practitioner visits was, for the lower estimate, taken as being the extra time (15 minutes) required to give the anistreplase, since the general practitioners involved in the Grampian region early anistreplase trial would have routinely visited all patients with suspected acute myocardial infarction. For the upper estimate it was assumed that a total of one hour would be required by the general practitioner to travel and treat the patient. These times were multiplied by the average hourly income rates for general practitioners, which were calculated from recommended income scales.

The probability of survival after thrombolysis was based on the latest data from patients in the Grampian early anistreplase trial and was calculated with the same methods as before .[2 4] At four years, community thrombolysis continued to give an additional probability of survival of 0.11 compared with hospital thrombolysis. Therefore, the number of people needed to be treated with community thrombolysis to save one life is nine (95% confidence interval 5 to 90).

## Results

Table 1 shows the marginal cost per life saved by community thrombolysis over hospital thrombolysis at four years. The cost per life saved—between £3890 and £8000—is calculated by dividing the additional cost of community thrombolysis by its additional effectiveness.

**Key messages**

- Community thrombolysis leads to increased survival relative to hospital thrombolysis at four years
- Relative to hospital thrombolysis, community thrombolysis provides this extra benefit at modest extra cost
- Methods of motivating general practitioners and facilitating routine community thrombolysis need to be ascertained

## Discussion

The cost per life saved by community thrombolysis is modest when compared to the cost effectiveness of other lifesaving treatments such as changing the thrombolytic drug used in hospital from streptokinase to alteplase.[6] Extra resources would be needed to promote routine community thrombolysis; if no new money is available a policy of community thrombolysis can be implemented only by reducing services elsewhere. For the policy maker the relevant decision is whether the extra resources required could be released from other programmes without losing benefits that are greater than those provided by community thrombolysis.

This evaluation has focused on whether community thrombolysis is a worthwhile use of resources for the health service as a whole. However, a policy of early thrombolysis would involve the transfer of workload and costs from secondary to primary care. The impacts on general practitioners' workload, remuneration, and drug budgets will be barriers to change. In this regard three important issues are, firstly, whether general practitioners should be remunerated for giving community thrombolysis; secondly, what other (non-financial) methods could be used to motivate general practitioners and facilitate routine community thrombolysis; and, thirdly, would extra drug costs be met from general practitioners' budgets or elsewhere.

The likely effect of community thrombolysis on future costs and consequences has not been estimated in this paper. Patients treated with community thrombolysis are likely to make a better recovery than patients treated with hospital thrombolysis, but they may require more treatment for future illnesses. From the health economics point of view it is difficult to draw firm conclusions about the expansion of community thrombolysis without investigating the opportunity cost of these long term effects. However, from the available data, prehospital thrombolysis seems a good use of resources. Future research should concentrate on two fronts: cardiovascular morbidity and its treatment costs and the impact on general practitioners of a policy of community thrombolysis.

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*Statistics notes*

# Cronbach's alpha

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**This is the 28th in a series of occasional notes on medical statistics**

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Many quantities of interest in medicine, such as anxiety or degree of handicap, are impossible to measure explicitly. Instead, we ask a series of questions and combine the answers into a single numerical value. Often this is done by simply adding a score from each answer. For example, the mini-HAQ is a measure of impairment developed for patients with cervical myelopathy.[1] This has 10 items (table 1) recording the degree of difficulty experienced in carrying out daily activities. Each item is scored from 1 (no difficulty) to 4 (can't do). The scores on the 10 items are summed to give the mini-HAQ score.

When items are used to form a scale they need to have internal consistency. The items should all measure the same thing, so they should be correlated with one another. A useful coefficient for assessing internal consistency is Cronbach's alpha.[2] The formula is:

$$\alpha = \frac{k}{k-1}\left(1-\frac{\Sigma s_i^2}{s_T^2}\right)$$

where $k$ is the number of items, $s_i^2$ is the variance of the $i$th item and $s_T^2$ is the variance of the total score formed by summing all the items. If the items are not simply added to make the score, but first multiplied by weighting coefficients, we multiply the item by its coefficient before calculating the variance $s_i^2$. Clearly, we must have at least two items—that is $k > 1$, or α will be undefined.

The coefficient works because the variance of the sum of a group of independent variables is the sum of their variances. If the variables are positively correlated, the variance of the sum will be increased. If the items making up the score are all identical and so perfectly correlated, all the $s_i^2$ will be equal and $s_T^2 = k^2 s_i^2$, so that $\Sigma s_i^2/s_T^2 = 1/k$ and $\alpha = 1$. On the other hand, if the items are all independent, then $s_T^2 = \Sigma s_i^2$ and $\alpha = 0$. Thus α will be 1 if the items are all the same and 0 if none is related to another.

**Table 1** Mini-HAQ scale in 249 severely impaired subjects

| Item | Mean score | SD of score $s_i$ |
|---|---|---|
| Stand | 2.96 | 1.04 |
| Get out of bed | 2.57 | 1.11 |
| Cut meat | 2.91 | 1.12 |
| Hold cup | 2.41 | 1.06 |
| Walk | 2.64 | 1.04 |
| Climb stairs | 3.06 | 1.04 |
| Wash | 3.25 | 1.01 |
| Use toilet | 2.59 | 1.09 |
| Open a jar | 2.86 | 1.02 |
| Enter/leave car | 2.80 | 1.03 |
| Mini-HAQ | 28.06 | $s_T = 8.80$ |

For the mini-HAQ example, the standard deviations of each item and the total score are shown in the table. We have $\Sigma s_i^2 = 11.16$, $s_T^2 = 77.44$, and $k = 10$. Putting these into the equation, we have

$$\alpha = \frac{10}{9} \times \left(1-\frac{11.16}{77.44}\right) = 0.95$$

which indicates a high degree of consistency.

For scales which are used as research tools to compare groups, α may be less than in the clinical situation, when the value of the scale for an individual is of interest. For comparing groups, α values of 0.7 to 0.8 are regarded as satisfactory. For the clinical application, much higher values of α are needed. The minimum is 0.90, and $\alpha = 0.95$, as here, is desirable.

In a recent example, McKinley *et al* devised a questionnaire to measure patient satisfaction with calls made by general practitioners out of hours.[3] This included eight separate scores, which they interpreted as measuring constructs such as satisfaction with communication and management, satisfaction with doctor's attitude, etc. They quoted α for each score, ranging from 0.61 to 0.88. They conclude that the questionnaire has satisfactory internal validity, as five of the eight scores had $\alpha > 0.7$. In this issue Bosma *et al* report similar values, from 0.67 to 0.84, for assessments of three characteristics of the work environment.[4]

Cronbach's alpha has a direct interpretation. The items in our test are only some of the many possible items which could be used to make the total score. If we were to choose two random samples of $k$ of these possible items, we would have two different scores each made up of $k$ items. The expected correlation between these scores is α.

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